PATENT SPECIFICATION

DRAWINGS ATTACHED

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1,156,423

1,156,423

Date of filing Complete Specification (under Section 3 (3) of the Patents Act 1949): 8 May, 1968.

Application Date: 8 Feb., 1967. *No. 5922/67.*

Application Date: 1 March, 1967. *No. 9662/67.*

Complete Specification Published: 25 June, 1969.

Index at acceptance: —**B7** HX7; **F2** E1G1

Int. Cl: —**B 62 d 1/18**

COMPLETE SPECIFICATION

Collapsible Steering Column

We: S.T.D. SERVICES LIMITED, a British Company of T.I. House, Five Ways, Edgbaston, Birmingham 16, do hereby declare the invention for which we pray that a Patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement: —

This invention relates to a collapsible steering column for vehicles. It is well-known nowadays that, in a road vehicle, a long and rigid steering column having its forward end near the front of the vehicle can be the cause of serious or fatal injuries to the driver in the event of a collision involving head-on impact. Various proposals have accordingly been made for constructing the steering shaft, i.e. the rotatable shaft connecting the steering wheel to the pinion in the steering box, so as to collapse telescopically under a heavy impact, and these have generally involved the use of splines, or D-section inner and outer telescoping members with friction clamps that allow movement only when a predetermined axially applied force is exceeded. Other proposals have involved sheer pins or plastically yielding torsion bars, and there have been proposals employing hydraulic fluid flowing through progressively restricted orifices. All of these have been relatively expensive, some have also been bulky, and in the case of the constructions involving friction clamps, the behaviour can become extremely uncertain after a long period of use, during which the parts may corrode or seize. Similarly, where the shaft has been enclosed in a tubular outer column it has been necessary to make this telescope in one way or another, but the methods so far proposed have involved the same objections of cost and of unreliability in behaviour after a long period.

An object of the invention is to provide a novel construction for a collapsible steering outer column or casing which is cheap to manufacture and economical in space, which will be of predictable behaviour and which will moreover retain its initial behaviour for an indefinite life.

According to the present invention a collapsible steering outer column or casing comprises two coaxial lengths of metal tube of different diameters connected together in such a manner that when an excessive axial compressive force is applied, the material of the wall of one or each of the tube lengths rolls back on itself in the manner of a rolling diaphragm and the resulting deformation of the metal absorbs the energy of the impact.

Preferably the rolling deformation is confined to one of the two tube lengths by making that portion weaker than the other. This can be done by making it of thinner gauge than the other and/or by providing longitudinally extending slots in it to leave individual webs or tongues that roll back on themselves.

The term 'steering outer column' which we use in this specification is to be understood as referring to any hollow non-rotating tubular structure which encloses the rotatable steering shaft or part of it and guides or supports that shaft or the steering wheel.

Two forms of steering outer column embodying by invention are illustrated by way of example in the accompanying drawings in which: —

Figure 1 is a diagrammatic elevation of a steering column assembly comprising a steering shaft, steering wheel and steering box, the shaft being enclosed in an outer column which incorporates two collapsible joints;

Figure 2 is a perspective view of the upper

collapsible joint of the outer column shown in Figure 1;

Figure 3 is a vertical section of the joint with the parts in their normal condition;

Figure 4 is a similar section showing the parts in the positions they assume after collapse;

Figure 5 is a cross-section on the line 5—5 of Figure 3;

Figure 6 is a partly cut away perspective view of a second embodiment; and

Figure 7 is an axial cross-section through the embodiment of Figure 6.

Referring first to Figures 1 to 5 the rotatable steering shaft 9 shown in Figure 1 which carries a steering wheel 10 at its upper end and at its lower end enters a steering box 11 is enclosed over the greater part of its length a non-rotating fixed outer column, formed from three coaxial lengths of tube, a central tube 12 and upper and lower tubes 13, 14 of smaller diameters each connected to the central tube by a collapsible joint allowing the tubes 13, 14 to telescope against a predetermined resistance into the tube 12 under excessive axial compressive stresses such as might be applied to the wheel by the body of the driver in a head-on collision with another vehicle or with a stationary object. The steering shaft 9 also incorporates a telescoping joint or joints, which may be of known kind, not illustrated here.

As the joints between the two tubes 13 and 14 and the tube 12 are identical only one need be described and the joint between the upper tube 13 and the tube 12 has been illustrated in Figures 2 to 5.

The tube 13 is formed of a suitable plastically deformable material such as mild steel and is of a diameter substantially less than that of the tube 12. At its lower end the tube 13 is formed with an outwardly projecting flange 15 which may be purely radial but is preferably doubled back so that it is of shallow trough shape, as shown more particularly in Figure 3, and its free end is welded or otherwise rigidly secured to the end of the tube 12.

When an excessive axial compressive force is applied to the column the tube 13 is forced axially into the tube 12, the wall of the tube 13 rolling back upon the inner surface of the tube 12 as shown in Figure 4.

The relative axial displacement between the tubes is resisted by the plastic deformation of the tube 13 as it rolls back, each annular portion of the tube being folded back on itself and then unfolded in turn, and this deformation absorbs and converts into heat a large quantity of kinetic energy in a short space of time.

The flange 15 and the adjacent part of the tube 13 may be continuous, in which case the yielding characteristics or the joint can be appropriately controlled by selection of the wall thickness of the tube 13 and the material of which it is made.

Preferably, however, angularly spaced axial slots 16 are made in the flanged end of the tube and are carried through the flange so that the flange and the adjacent part of the tube are reduced to angularly spaced webs or tongues 17. In the form illustrated there are four slots, leaving four webs.

With this arrangement the yielding characteristics of the joint can be controlled by varying the circumferential width of the slots 16 and hence of the webs or tongues.

The slots may be parallel-sided as shown or they may be tapered in width in such a direction that the circumferential width of the webs or tongues increases in a direction away from the flange and the resistance of the joint to yielding increases progressively with length of axial displacement.

Regardless of whether the slots are tapered or are parallel-sided, it should be made clear that the column can continue to absorb energy even after it has collapsed to full extent of the lengths of the slots, i.e. to the condition shown in Figure 4. As it collapses beyond this condition it absorbs energy by actual tearing of the metal of one or both tube portions, especially of remaining part of the slotted tube.

In a modification the roles of the two tubes 12 and 13 may be reversed, the tube 12 being formed at its upper end with an inturned flange which is welded to the lower end of the tube 13, and on relative axial displacement between the tubes the outer tube 12 rolls up on to the outer surface of the tube 13. In that case the tube 12 may be of smaller wall thickness than the tube 13 and/or its upper end may be slotted to divide it into a number of angularly spaced webs or tongues. In a steering outer column as shown in Figure 1 and incorporating two collapsible joints as described above, the axial lengths of the three tubes may be such that the tubes 13 and 14 will butt together within the tube 12 on completion of the maximum desired length of collapse of the column.

In an other modification the collapsible joint may be formed by a single length of tube manipulated to provide two coaxial parts of different diameter connected by a continuous or divided annular web of trough or similar cross-section. The wall of one part may be of less thickness than that of the wall of the other part to confine the rolling action on telescoping of the parts under excessive axial load to the first part. Alternatively the first part may be formed with longitudinal slots extending into or through the web for the same purpose.

It will be understood that the difference in diameter between the two tube portions must be such that there is a clearance between the outside diameter of the smaller portion and

the inside of the larger portion sufficient to receive the rolling back portion of the one or the other on collapse.

In the embodiment illustrated in Figures 6 and 7 one portion 18 of the steering outer column has an out-turned flange 19 at its free end, by which it is slidably guided in a second column portion 20. The two portions overlap and the second portion 20 has an in-turned flange 21 at its free end to guide it slidably on the first portion. Thus an annular clearance space is defined between the overlapping parts of the two column portions and in this space there is located a sleeve 22 of which the upper part is welded to the inner column portion 18. Four tapering longitudinal slots 23 extend upwards from the lower end of the sleeve to define tapering tongues 24 of which the lower ends 25 are turned outwards and back on themselves and welded to the inside of the portion 20.

The behaviour of the embodiment of Figures 6 and 7 is the same as that of Figures 2 to 5 in that, when excessive axial loading is applied to the column, as in a crash, the tongues 24 are subjected to a rolling deformation which absorbs energy. The tapering shape of the tongues results in an axial resistance that increases progressively during the collapse. The only other differences from the embodiment of Figures 2 to 5 are the fact that the tongues are formed on a separate sleeve and the presence of the flanges 19 and 21 by which the column portions are mutually guided during the collapse.

Any of the steering outer columns described above may carry a stationary bearing sleeve or spaced bearing sleeves for the rotatable column and/or the steering wheel itself. The steering wheel could be rotatably mounted on the upper end of the column while the lower end would be secured in a bracket mounted on the dash or firewall or other convenient part of the vehicle. Alternatively the column could extend through the firewall, or it could extend from the firewall down to the steering box.

All the collapsible outer columns described herein have a smooth and predictable yielding behaviour that is virtually unaffected by time. As compared with known forms of collapsible columns, they have the important advantage of exhibiting little or no "Stiction", that is to say the load required to start the collapse is maintained smoothly rather than being replaced by a substantially lower load during movement.

The force required to cause initial axial movement and to continue that movement will depend on the ductility and strength of the metal used, the diameter and wall thickness of at least one part of the assembly and the number and configuration of the slots where these are provided.

It will be understood that, where the strength of the material of the two portions of the column is chosen appropriately it would be possible, though not easy, for both portions to roll back on themselves simultaneously.

Thus collapsible steering columns as described herein may be provided with varied force/distance moved characteristics by selection of these factors.

A further point to observe is that the simple structure according to the invention forms simultaneously the energy-absorbing means and at the same time the casing or outer column itself. In contrast to some known structures no additional energy-absorbing provisions, which add weight and cost, are required.

WHAT WE CLAIM IS:—

1. A collapsible steering outer column for vehicles comprising two coaxial lengths of metal tube of different diameters connected together in such a manner that when an excessive axial compressive force is applied, the material of the wall of one or each of the tube lengths, which is of ductile metal, rolls back on itself in the manner of a rolling diaphragm and the resulting deformation of the metal absorbs the energy of impact.

2. A collapsible steering outer column according to Claim 1 in which one of the lengths of tube is made more readily deformable than the other.

3. A collapsible steering outer column according to Claim 2 in which the more collapsible length has longitudinal slots that divide a part of its length into individual longitudinally extending tongues.

4. A collapsible steering outer column according to Claim 2 or Claim 3 in which the free end of the more collapsible tube length is turned radially and joined to the other tube length.

5. A collapsible steering outer column according to Claim 4 in which the radial portion of the more collapsible tube length is joined to an end of the other tube length, and in the uncollapsed condition the two tube lengths do not substantially overlap.

6. A collapsible steering outer column according to Claim 4 in which the radial portion of the more collapsible tube length is joined to an intermediate part of the other tube length.

7. A collapsible steering outer column according to any of Claims 2 to 6 in which the more collapsible length is of smaller diameter than the other and rolls back on itself outwards within the other length on collapse.

8. A collapsible steering outer column according to any of Claims 2 to 7 in which the more collapsible length of tube is in the form of a sleeve secured to a third length of tube.

9. A collapsible steering outer column

according to Claim 8 in which the third length of tube and the said other length of tube partially overlap in the uncollapsed condition and means are provided for guiding the third length and the said other length with respect to each other on collapse.

10. A collapsible steering outer column according to Claim 9 in which the guiding means comprise a flange on the end of the third tube and/or other tube, turned inwards or outwards to come into sliding engagement with the wall of the other tube and/or third tube respectively.

11. A collapsible steering outer column according to any of Claims 1 to 10 including a further tube length connected to one of the said two coaxial lengths in the same manner as the said two coaxial lengths are connected together, so that there are two regions in the overall length of the column in which a rolling back action occurs on axial collapse.

12. A collapsible steering outer column substantially as described with reference to Figures 1 to 5 of the accompanying drawings.

13. A collapsible steering column substantially as described with reference to Figures 1, 6 and 7 of the accompanying drawings.

14. A vehicle equipped with a steering shaft carrying a steering wheel and mounted for rotation in a steering outer column according to any of the preceding claims.

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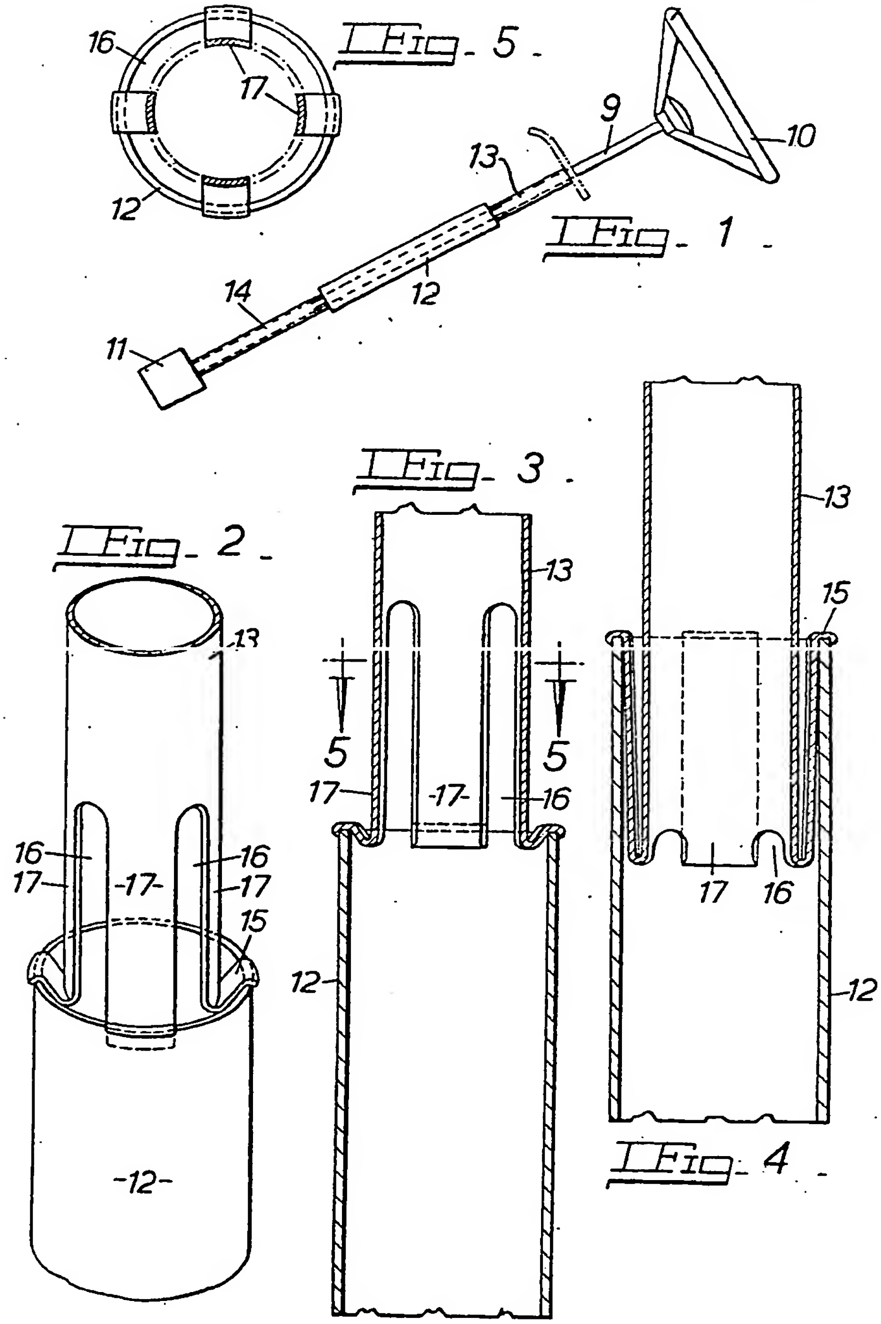
Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1969.
Published by the Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

1156423 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1



1156423 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

Fig. 6

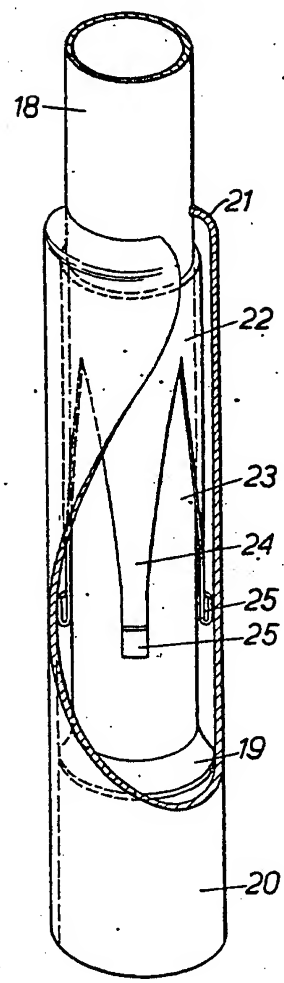


Fig. 7